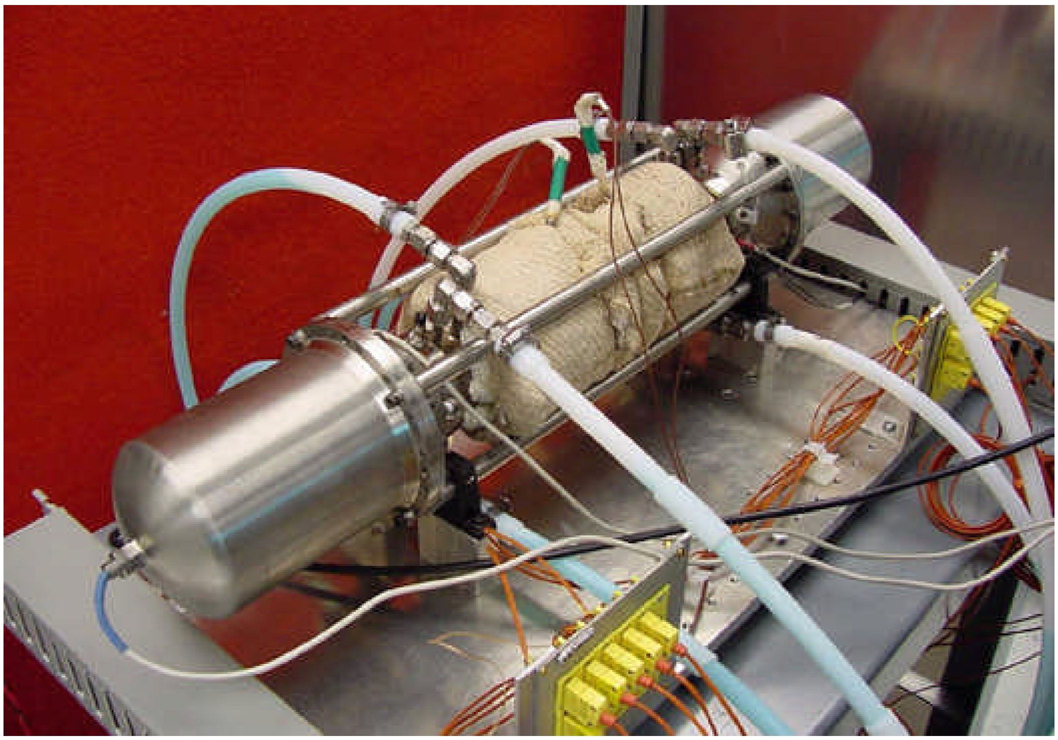
Stirling Convertor Technologies Being Developed for a Stirling Radioisotope Generator

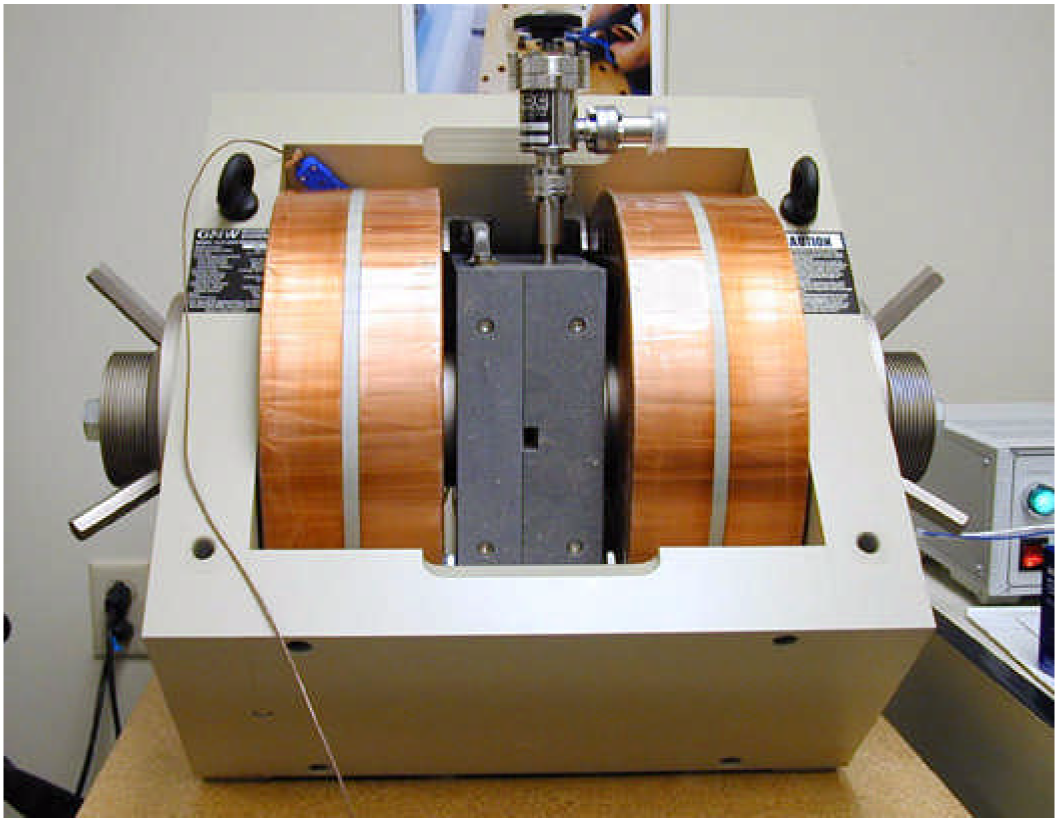
The Department of Energy, Lockheed Martin, Stirling Technology Company (STC), and the NASA Glenn Research Center are developing a high-efficiency Stirling Radioisotope Generator (SRG) for NASA space science missions. The SRG is being developed for multimission use, including providing electric power for unmanned Mars rovers and deep space missions. On Mars, rovers with SRGs would be used for missions that might not be able to use photovoltaic power systems, such as exploration at high Martian latitudes and missions of long duration. The projected SRG system efficiency of 23 percent will reduce the required amount of radioisotope by a factor of 4 or more in comparison to currently used Radioisotope Thermoelectric Generators.



Stirling Technology Demonstration Convertors for a Stirling Radioisotope Generator being tested at Glenn.

The Department of Energy recently named Lockheed Martin as the system integration contractor. Lockheed Martin has begun to develop the SRG engineering unit under contract to the Department of Energy, and has contract options to develop the qualification unit and the first flight units. The developers expect the SRG to produce about 114 Wdc at the beginning of mission, using two opposed Stirling convertors and two General Purpose Heat Source modules. STC previously developed the Stirling

convertor under contract to the Department of Energy and is now providing further development as a subcontractor to Lockheed Martin.



Aging tests of neodymium-iron-boron permanent magnets.

Glenn is conducting an in-house technology project to assist in developing the convertor for space qualification and mission implementation. A key milestone was recently reached with the accumulation of 12 000 hr of long-term aging on two types of neodymium-iron-boron permanent magnets. These tests are characterizing any possible aging in the strength or demagnetization resistance of the magnets used in the linear alternator. Preparations are underway for a thermal/vacuum system demonstration and unattended operation during endurance testing of the 55-We Technology Demonstration Convertors. In addition, Glenn is developing a charging system for the convertors to ensure clean fills of the helium working fluid and to monitor levels of any possible contaminants at different test intervals. Possible oxidation effects depend on the level of any oxygen contamination-regenerator materials and displacer radiation shields are now being evaluated for possible oxidation effects.

Inconel 718 creep testing.

Heater head life assessment efforts are continuing, and a probabilistic durability assessment has been started. This will look at the effects of variations and uncertainties in the heater head geometry, convertor operating conditions, and Inconel 718 flight material creep data. Over 125 000 hr of creep testing at various stress levels have been completed on samples of the Inconel 718 heater head flight material. A test rig is nearing completion for structural benchmark testing of complete heater heads and heater head shells to factor in the effects of biaxial stresses and to calibrate and validate the heater head life model. The key magnet/lamination epoxy bond is being tested for performance and lifetime characteristics, and alternate methods of bonding and insulating lamination stacks for the linear alternator are being evaluated. Other efforts include independent verification testing of the Technology Demonstration Convertors, three-dimensional linear alternator magnetic analysis, launch environment characterization testing, electromagnetic interference and electromagnetic compatibility characterization and reduction, and reliability studies.

Glenn has also initiated efforts to develop advanced Stirling technologies. Cleveland State University is progressing toward a multidimensional Stirling computational fluid dynamics code capable of modeling complete convertors. A two-dimensional model is now operational. Validation efforts at both Cleveland State and the University of Minnesota are complementing the code development. This year, new efforts were started on the design for a lightweight convertor, advanced controllers, high-temperature materials, and an end-

to-end system dynamics model. Performance and mass improvement goals have been established for second- and third-generation Stirling radioisotope power systems.

Find out more about the research of Glenn's Thermo-Mechanical Systems Branch http://www.grc.nasa.gov/WWW/tmsb/.

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Glenn contacts: Richard K. Shaltens, 216-433-6138, Richard.K.Shaltens@nasa.gov; Jeffrey G. Schreiber, 216-433-6144, Jeffrey.G.Schreiber@nasa.gov; and Lanny G. Thieme, 216-433-6119, Lanny.G.Thieme@nasa.gov
Author: Lanny G. Thieme

Headquarters program office: OSS
Programs/Projects: SRG, Mars exploration, Mobile Science Laboratory, New Frontiers